Climate Policies, Macroprudential Regulation, and the Welfare Cost of Business Cycles

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Background and Motivation

- Wide consensus on the need for large reductions in greenhouse gas (GHG) emissions

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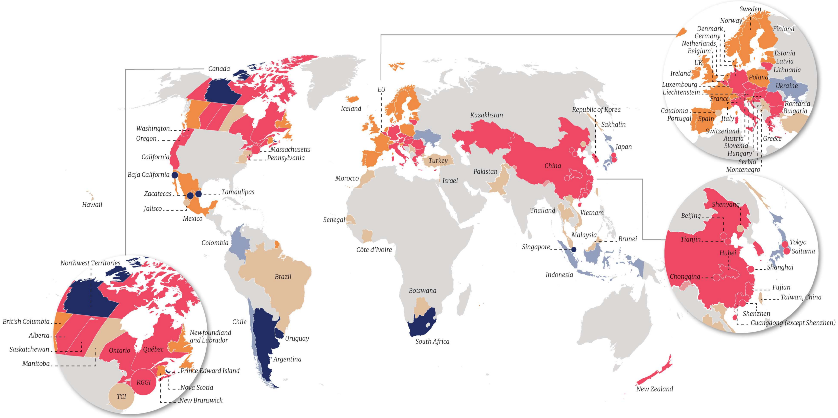
- Policy and academic debate around pros and cons of carbon taxes vs. cap-and-trade schemes Instruments

Background and Motivation

Carbon Pricing Worldwide (World Bank 2023)



- ETS implemented or scheduled for implementation
- Carbon tax implemented or scheduled for implementation
- ETS and carbon tax implemented or scheduled
- ETS implemented or scheduled, carbon tax under consideration
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- ETS or carbon tax under consideration

Background and Motivation

The Price vs. Quantity Debate

- *'Price vs. quantity'* debate since Weitzman (1974) around pros and cons of **carbon taxes** and **cap-and-trade schemes**: in the presence of *uncertainty* these two policies are not equivalent!
- The two instruments can differ in terms of economic and environmental performance:
  - more if in an open economy
  - more if in general equilibrium
  - more if other market failures are present

The Price vs. Quantity Debate: a Business Cycle Perspective

- CO_2 emissions are highly pro-cyclical cycle
- Costs and benefits of carbon pricing policies vary over the course of business cycles (e.g. Heutel, 2012)
- These policies perform differently but welfare costs are quantitatively very similar in RBC or NK models (e.g. Fischer and Springborn, 2011 and Annicchiarico and Di Dio, 2015)

Background and Motivation

Research Gap

- Previous models (both RBC and NK) abstract from financial markets:
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- Changes in financial and credit conditions:
  - are important in the propagation of the business cycle
  - can affect the transmission of policy interventions

Our Research Questions

RQ1: Can climate policy interact with credit market imperfections and the way shocks are transmitted?

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RQ3: Can macroprudential policy align the performance of different carbon pricing policies over the business cycle?

Our Research Questions: Answers

RQ1: Can climate policy interact with credit market imperfections and the way shocks are transmitted? Yes!

RQ2: With financial frictions, are welfare costs of the business cycle significantly different between carbon taxes and cap-and-trade schemes? Yes!

RQ3: Can macroprudential policy align the performance of different carbon pricing policies over the business cycle? Yes!

What We Do

- Dynamic stochastic general equilibrium model (RBC) with:
  - Environmental variables (negative externality as in Golosov et al., 2014 and abatement as in the DICE model)
  - Financial frictions (costly state verification as in Bernanke et al., 1999 and Christiano et al., 2014)

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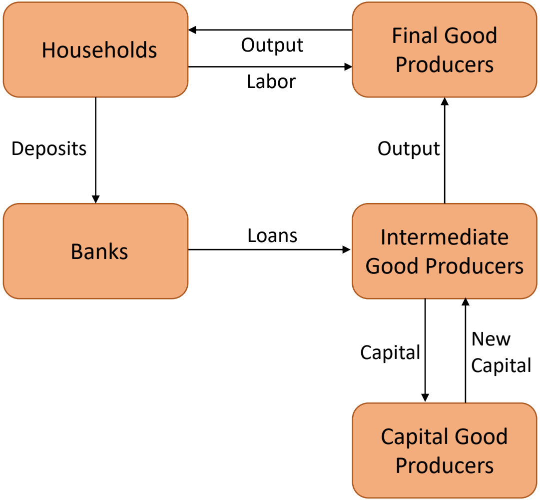
- Role of (optimal) macroprudential regulation

The Model

The Model Economy

Skeleton



The Model Economy
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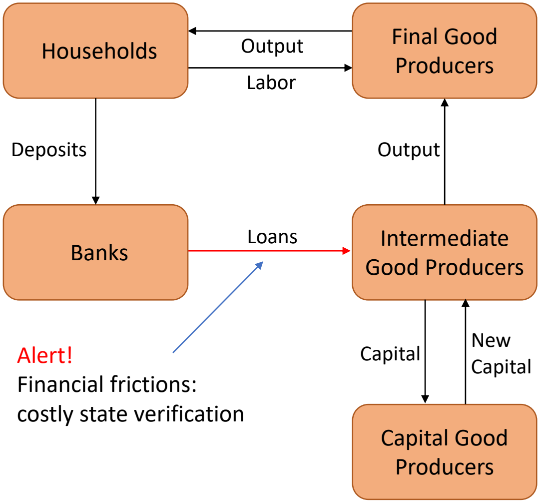

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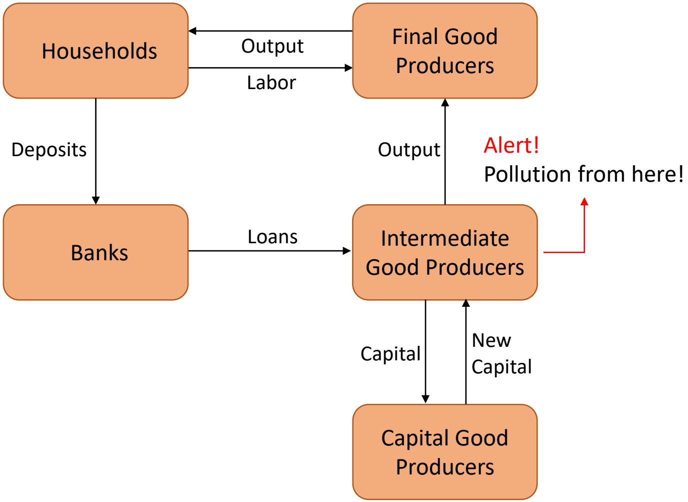

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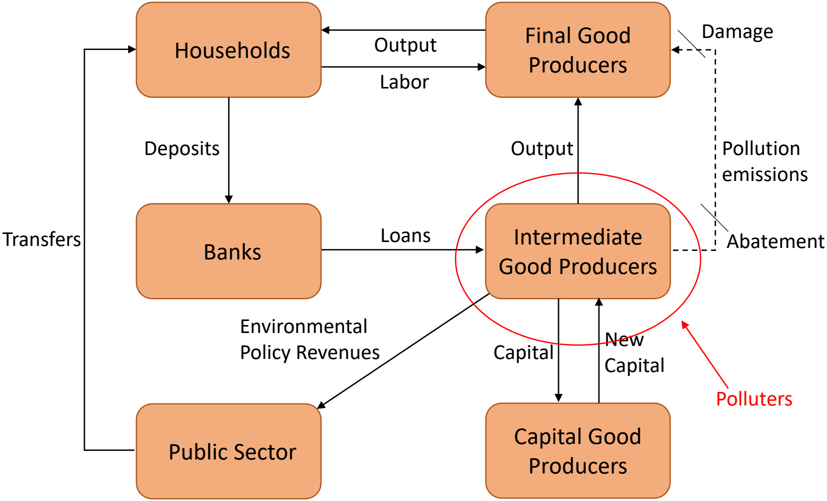

- Households maximize expected utility:

$$U_0 = \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \frac{\left[C_t^{\sigma_L} (1 - H_t)^{1-\sigma_L} \right]^{1-\eta}}{1-\eta} \right\}$$

subject to the budget constraint:

$$C_t + B_{t+1}^H \leq W_t H_t + (1 + R_{t-1}) B_t^H + T_t$$

C_t consumption, H_t labor paying wage W_t, B_t^H risk-free deposits, R_t risk-free rate, T_t lump-sum payments

The Model Economy

Final-Good Producers

- The final good is produced according to the following Cobb-Douglas technology in intermediate good X and labor H:

$$Y_t = A_t X_t^{\alpha} H_t^{1-\alpha}$$

- A_t is a measure of total factor productivity (TFP) negatively affected by pollution stock

The Model Economy

Pollution and Damage

- Polluting gases accumulate into stock M_t:

$$M_t - \underbrace{\bar{M}}_{\substack{\text{pre-industrial}\\ \text{stock}}} = \sum_{s=0}^{t-T} (1 - \underbrace{\delta_M}_{\text{decay rate}})^s (E_{t-s} + \underbrace{E^*_{t-s}}_{\text{RoW emissions}})$$

- As in Golosov (2014), the damage function:

$$1 - D_t(M_t) = \exp\left(-\xi\left(M_t - \bar{M}\right)\right)$$

- Pollution negatively affects TFP, A_t, at the final-good level:

$$A_t = \bar{A}_t(1 - D_t(M_t))$$

- Source of uncertainty (i): $\bar{A}_t$ is subject to shocks

- A mass of intermediate-good firms, whose state is summarized by net worth, $N \geq 0$, inherited from period t production
- At the end of period t, each N-type firm obtains a loan B^N_{t+1} from a bank, which is then combined with net worth to purchase capital:

$$\underbrace{Q_{K,t}K^N_{t+1}}_{\text{capital value}} = \underbrace{N}_{\text{net worth}} + \underbrace{B^N_{t+1}}_{\text{loan from bank}}$$

$\rightarrow$ leverage $L^N_t = \frac{Q_{K,t}K^N_{t+1}}{N}$

The Model Economy

Intermediate-Good Producers: The Polluters

- Firms undertake the period $t+1$ production process according to technology:

$$X_{t+1}^{N} = \omega K_{t+1}^{N}$$

ω a unit-mean lognormally distributed idiosyncratic shock on productivity with σ_t the standard deviation of log ω

- If ω less then a cut-off, $\bar{\omega}^{N}$, the producer goes into bankruptcy!
- Source of uncertainty (ii): σ_t can vary over time!

$$\log \sigma_t = (1-\rho_\sigma)\log \sigma + \rho_\sigma \log \sigma_{t-1} + \varepsilon_{\sigma,t}$$

Capital-Good Producers Banks

The Model Economy

Intermediate-Good Producers: The Polluters

- The production process is polluting, but producers can abate emissions:

$$\underbrace{E_{t+1}^N}_{\text{emissions}} = \chi(1 - \underbrace{\kappa_{t+1}^N}_{\text{abatement}})X_{t+1}^N$$

- Abatement cost function per unit of output:

$$\theta_1 \left(\kappa_{t+1}^N\right)^{\theta_2}, \theta_2 > 1$$

- Polluters are subject to environmental policy and pay P_{t+1}^E for each unit of emissions

The Model Economy

Environmental Policy

To control pollution, the public sector has two alternative environmental policy tools:

- a **carbon tax**: a fixed tax rate $\bar{P}^E$ per unit of emission
- a **cap-and-trade**: a cap $\bar{E}$ on overall emissions of the economy

Revenues from pollution policies are redistributed to households as lump-sum transfers

Intermediate-Good Producers: The Polluters

- At the end of period $t+1$ the return on production is

$$1+\mathrm{R}^k_{t+1} = \frac{\overbrace{r^x_{t+1}}^{\text{depends on TFP}} + (1-\delta)Q_{K,t+1}}{Q_{K,t}} - \frac{\overbrace{\left[\theta_1\left(\kappa_{t+1}\right)^{\theta_2} + P^E_{t+1}\chi(1-\kappa_{t+1})\right]}^{\text{environmental-compliance costs}}}{Q_{K,t}}$$

- r^x_{t+1}: price paid by final good-producers
- $Q_{K,t}$: price paid for capital
- $(1-\delta)Q_{K,t+1}$: what is received from capital-good producers for the sale of capital

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Relative Compliance Costs

- r^x_{t+1}: price paid by final good-producers
- $Q_{K,t}$: price paid for capital
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The Model Economy

Banks

- Perfectly competitive banks
  - issue deposits to households and pay a risk free rate R
  - make loans B^N to polluters at gross rate Z
  - collect value of assets from bankrupt polluters, but pay monitoring cost

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$$\underbrace{(1-F_t(\bar{\omega}^N_{t+1}))B^N_{t+1}Z^N_{t+1}}_{\text{payments from loans}} + \underbrace{(1-\mu)\int_0^{\bar{\omega}^N_{t+1}} \omega dF_t(\omega)(1+R^k_{t+1})Q_{K,t}K^N_{t+1}}_{\text{assets from bankrupt polluters - monitoring cost}}$$

$$= \underbrace{B^N_{t+1}(1+R_t)}_{\text{payments to depositors}}$$

- The zero-profit condition can be re-written as

$$[\Gamma_t(\bar{\omega}^N_{t+1}) - \mu G_t(\bar{\omega}^N_{t+1})]\frac{Q_{K,t}K^N_{t+1}}{B^N_{t+1}}(1+R^k_{t+1}) = 1 + R_t$$

- **Market failure**: the risk-free interest rate R_t is equal to the average and not to the marginal return on production
- The economy is characterized by under-lending

Calibration

The Model Economy

Calibration and Model Solution

- Standard three-step procedure
  - Calibrate the model to the US economy (quarterly frequency)
  - Characterize the deterministic steady state of the model
  - Model solution via second-order perturbation method

Calibration

	Description	Value
Standard Macroeconomic Parameters		
β	Discount factor	0.99
δ	Depreciation rate of capital	0.025
α	Capital share	0.4
γ_I	Investment installation cost curvature	20
σ_L	Preference parameter (implied)	0.21
η	Preference parameter (implied)	5.72
RRA	Coefficient of relative risk aversion	2
$\bar{A}$	Total factor productivity (implied)	1.26
Financial Parameters		
μ	Monitoring cost	0.21
$1-\gamma$	Fraction of net worth to households	0.035
σ	Standard deviation of log ω	0.30
Environmental Parameters		
$\bar{M}$	Pre-industrial concentration of carbon	581
δ_M	Decay rate of greenhouse gases	0.0021
χ	Emission intensity parameter (implied)	0.017
ξ	Damage function parameter	7.86e-06
θ_1	Abatement cost function parameter	1
θ_2	Abatement cost function parameter	2.6

Steady State

	Description	Value
Steady state ratios and values		
C/Y^n	Consumption	0.80
I/Y^n	Total investment	0.20
Tr/Y^n	Environmental tax revenues %	0.7
H	Hours	0.17
$Z-(1+R)$	Spread p.p.	0.52
$F(\bar{\omega})$	Percent of bankrupt business p/quarter	1.5
M	Stock of concentration of carbon GtC	891
$E/(E+E^*)$	Share of US emissions	0.20

Moments Exogenous processes

Price and Quantity Regulations: Economic Dynamics and Welfare Cost of Business Cycles

How the Model Economy Works (in words)

- In the case of positive shocks on TFP

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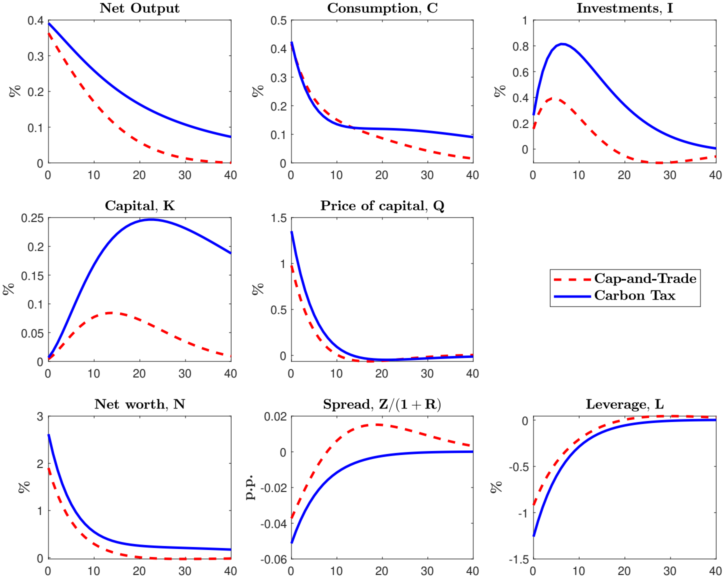
- This roundabout mechanism of financial acceleration amplifies the effects
- **Environmental policy interferes with this mechanism!**

IRFs to a Positive Aggregate TFP Shock



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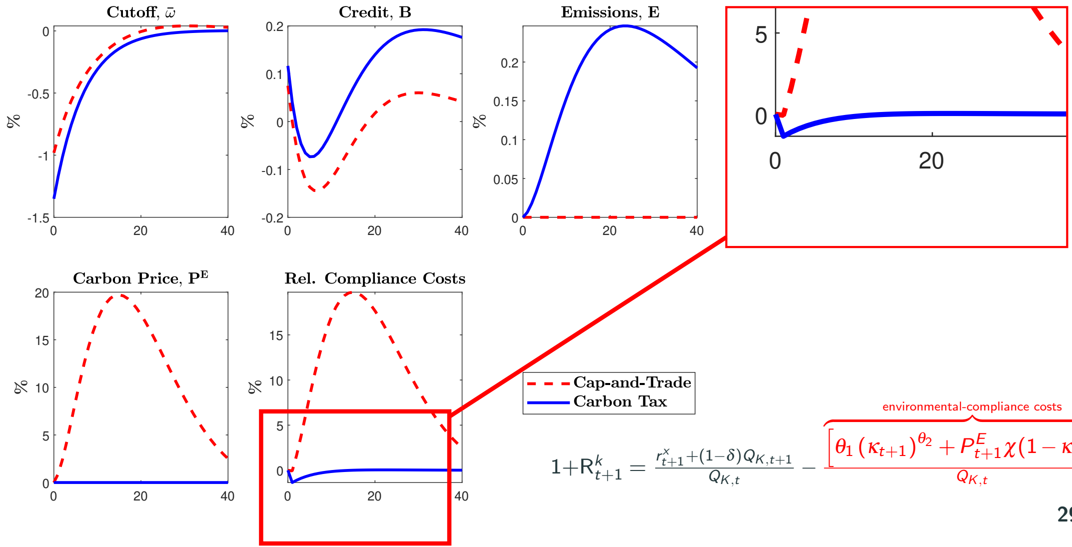


environmental-compliance costs

$$1+R^k_{t+1} = \frac{r^x_{t+1}+(1-\delta)Q_{K,t+1}}{Q_{K,t}} - \frac{\overbrace{\left[\theta_1\left(\kappa_{t+1}\right)^{\theta_2} + P^E_{t+1}\chi(1-\kappa_{t+1})\right]}^{\text{environmental-compliance costs}}}{Q_{K,t}}$$

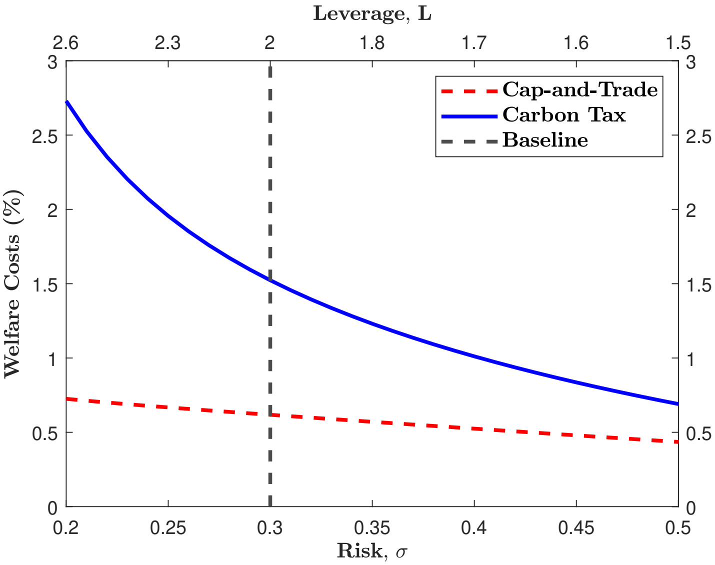
Welfare Costs, Means and (Volatility)

	Cap-and-Trade	Carbon Tax
Net Output	-0.5691	-2.0569
	(0.0189)	(0.0360)
Consumption	-0.4837	-1.5935
	(0.0115)	(0.0196)
Investment	-0.9034	-3.8697
	(0.0113)	(0.0236)
Net worth	3.0069	0.9986
	(0.7103)	(0.8225)
Spread	0.1573	0.2728
	(0.0082)	(0.0111)
Welfare costs	0.6178	1.5231

Note: Results are reported in % deviations from the steady state (spread in p.p.d.). Welfare in consumption equivalent units

Environmental Variables Alternative welfare measures Sensitivity

The Welfare Cost of Business Cycles, Risk and Leverage



What if Environmental Policies Are Hybrid?

Hybrid Environmental Policy Rules

- Existing landscape of carbon pricing is complex!

cap-and-trade ├──────────┤ carbon tax

hybrid policies

- Hybrid policies: EU ETS Market Stability Reserve; carbon tax scheduled increases paused in downturns; floors or ceiling on allowances prices

Hybrid Environmental Policy Rules

- Two state-contingent rules:
  - Adjustable cap:

$$E_t = \bar{E}\left(\frac{Y_t^n}{Y^n}\right)^{\nu}$$

  - Adjustable tax:

$$P_t^E = \bar{P}^E\left(\frac{Y_t^n}{Y^n}\right)^{\tau}$$

Variables with no subscript steady-state values

ν and τ set "optimally" to reduce welfare costs

Welfare

Welfare Costs, Means and (Volatility) - Optimal Env. Policy Rules

	Optimal Cap	Optimal Tax
Net Output	-0.5325	-1.5911
	(0.0108)	(0.0269)
Consumption	-0.4171	-1.2266
	(0.0082)	(0.0149)
Investment	-0.9843	-3.0171
	(0.0056)	(0.0176)
Net worth	1.0564	0.9824
	(0.6622)	(0.7166)
Spread	0.1135	0.2245
	(0.0075)	(0.0090)
Welfare costs	0.4528	1.1811

Note: Results are reported in % deviations from the steady state (spread in p.p.d.). Welfare in consumption equivalent units

Environmental Variables

Macroprudential Regulation

Macroprudential Regulation

- Static and optimal reserve requirements
- Static and optimal subsidy to depositors

- Need for a *model-consistent* financial regulation: Reserve requirements for lending institutions
- Φ_t fraction of deposits banks can loan out
- Banks issue $B^H_{t+1} = B_{t+1}/\Phi_t$ deposits to finance B_{t+1} loans

Macroprudential Regulation

Reserve Requirements

- Static regulation:

$$\Phi_t = \Phi^\star = 0.98$$

- Dynamic regulation: Φ_t as a function of a financial indicator FI_t

$$\Phi_t = \Phi^\star \left(FI_t\right)^{-\psi},$$

- Two dynamic regulations:
  1. Credit growth
  2. Asset price
- ψ set "optimally" to reduce welfare costs

The Welfare Cost of Business Cycles under Reserve Requirements

	Cap-and-Trade	Carbon Tax
Baseline	0.6178	1.5231
Static Regulation	0.1957 $\psi = 0$	0.3863 $\psi = 0$
Credit Growth Rule	0.1207 $\psi^B = 1.05$	0.3231 $\psi^B = 0.99$
Asset Price Rule	0.1807 $\psi^Q = 0.72$	0.2310 $\psi^Q = 0.68$

Moments Environmentall variables Back

Macroprudential Regulation

The Welfare Cost of Business Cycles under Reserve Requirements

	Cap-and-Trade	Carbon Tax	No Policy
Baseline	0.6178	1.5231	1.5522
Static Regulation	0.1957	0.3863	0.3910
	$\psi = 0$	$\psi = 0$	$\psi = 0$
Credit Growth Rule	0.1207	0.3231	0.3259
	$\psi^B = 1.05$	$\psi^B = 0.99$	1.00
Asset Price Rule	0.1807	0.2310	0.2339
	$\psi^Q = 0.72$	$\psi^Q = 0.68$	$\psi^Q = 0.675$

Optimal Policy Mix

The Welfare Costs of Business Cycles

	Optimal Cap-and-Trade	Optimal Carbon Tax
Baseline $\Phi_t = 1$	0.4528 $\nu = -2.3380$	1.1811 $\tau = 52.2245$
$\Phi_t = \Phi^\star$	0.1883 $\nu = -0.3695$	0.3455 $\tau = 24.2990$
$\Phi_t = \Phi^\star \left(\frac{B_{t+1}}{B_t}\right)^{-\psi^B}$	0.1164 $\psi^B = 1.0482,\ \nu = -0.3011$	0.2695 $\psi^B = 1.0475,\ \nu = -44.6699$
$\Phi_t = \Phi^\star \left(\frac{Q_{K,t}}{Q_{K,t-1}}\right)^{-\psi^Q}$	0.1776 $\psi^Q = 0.6890,\ \nu = -0.2391$	0.2168 $\psi^Q = 0.7000,\ \nu = 9.1723$

Macroprudential Regulation

Interest Rate Subsidy to Depositors

- Reserve requirements problematic: lower welfare costs of business cycles around a more distorted equilibrium
- To reduce under-lending need to increase savings: a subsidy can help so that deposits are remunerated at factor $(1+R)(1+s)$
- Time-varying adjustment rule

$$1+s_t=(1+s^\star)\left(\frac{B_{t+1}}{B_t}\right)^{-\varkappa}$$

- Mean welfare max at $s^\star=1.00\%$

Steady state

Macroprudential Regulation

The Welfare Cost of Business Cycles under an Interest Rate Subsidy to Depositors

	Cap-and-Trade	Carbon Tax
Baseline	0.6178	1.5231
Static Regulation	1.1028 $\varkappa = 0$	3.5597 $\varkappa = 0$
Credit Growth Rule	0.2506 $\varkappa = 1.3190$	0.4706 $\varkappa = 1.3330$

Baseline

Conclusions

Conclusions

- More *volatile* economy under a carbon tax
- Financial accelerator mechanism *reversed* under a cap-and-trade
- Welfare costs of the business cycle *very* different under the two regimes: the choice of the tool is not innocuous
- Macroprudential regulation can *de facto* align the performance of climate actions
- **Policy implication: financial regulators can help reduce the uncertainty inherent to each environmental policy tool, enlarging the menu of climate policy options**

Thank you

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Appendix

The two main ways of pricing carbon

Cap-and-Trade: the government sets an emissions cap and issues a quantity of emission allowances consistent with that cap. Emitters must buy allowances for each ton of GHG they emit

- less uncertainty about emission levels
- BUT more uncertainty about compliance costs

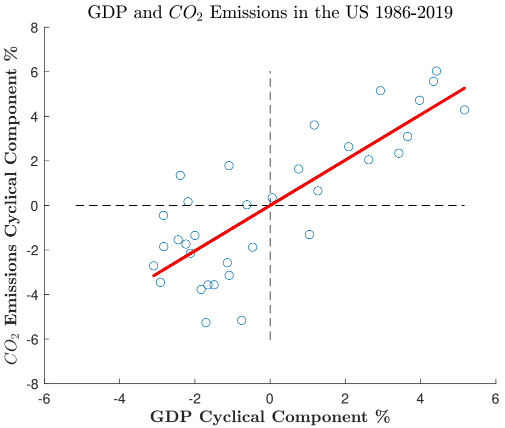
Carbon Tax: the government sets a tax for each ton of GHG

- less uncertainty about compliance costs
- BUT more uncertainty about emission levels

back

Background and Motivation iv

Emissions and the Business Cycle



Back

The Model Economy

Capital-Good Producers

- In period t capital producers purchase capital from intermediate goods producers for the price $Q_{K,t}$, rebuild depreciated capital, and construct new capital K_{t+1} with the following technology:

$$K_{t+1} = (1-\delta)K_t + \left(1 - S\left(\frac{I_t}{I_{t-1}}\right)\right) I_t,$$

  where $S(\bullet)$installation costs increasing in the rate of investment growth, $S(1) = 0$, $S'(1) = 0$, $S''[.] > 1$
- The new capital stock is sold for the same price $Q_{K,t}$

Back to polluters

The Model Economy

Intermediate-Good Producers: The Polluters and the 'Large Family' Assumption

- Firms are owned by households, which in turn instruct polluting producers to maximize their expected net worth
- A fraction of each producer's net worth is transferred to households as a lump-sum; households transfer resources as a lump sum to each producers.
- Net worth evolves as

$$N_{t+1} = \gamma[1 - \Gamma_{t-1}(\bar{\omega}_t)](1 + R_t^k)Q_{K,t-1}K_t + W_t^p,$$

where W_t^p the amount of lump-sum transfers made by households.

back

Exogenous Processes

	Description	Value
Shocks		
$\rho_{\bar{A}}$	Autocorrelation TFP shock	0.90
ρ_{σ}	Autocorrelation risk shock	0.95
$sd\ \varepsilon_{\bar{A}}$	Standard deviation TFP shock	0.0034
$sd\ \varepsilon_{\sigma}$	Standard deviation risk shock	0.065

Back

Data and Model - Moments

	Model	Data
Standard Deviation		
σ_Y	0.010	0.010
σ_I/σ_Y	3.72	4.67
σ_C/σ_Y	0.77	0.85
Cross-Correlations		
$\rho_{I,Y}$	0.80	0.89
$\rho_{C,Y}$	0.67	0.92
First-Order Autocorrelation		
ρ_Y	0.79	0.90
ρ_I	0.94	0.88
ρ_C	0.67	0.86

Note: the table reports the moments generated by the model (under carbon tax) and those of the US HP-filtered quarterly data over the period 1985Q1-2019Q4, retrieved from FRED.

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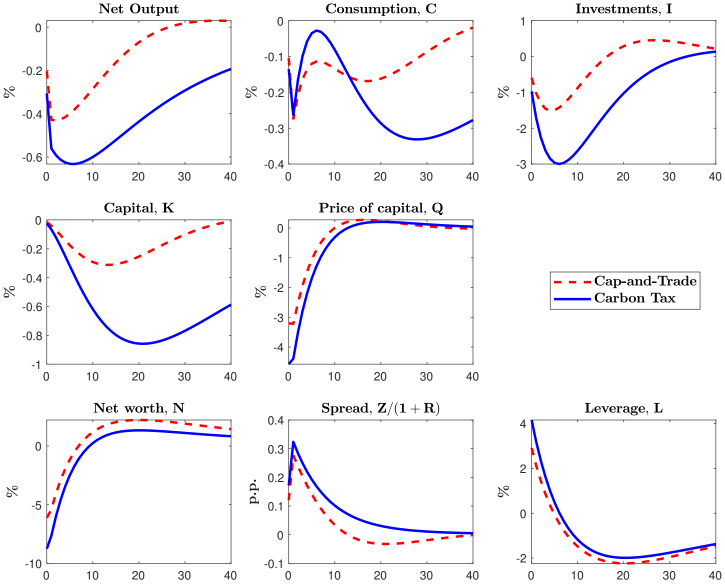
How the Model Economy Works (in words)

- In the case of a positive risk shock

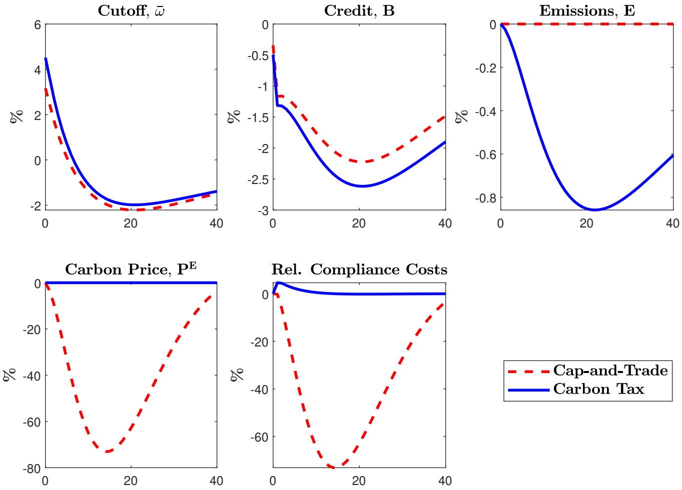
How the Model Economy Works (in words)

- In the case of a positive risk shock
  - First-round effects: the probability of an adverse idiosyncratic shock $\uparrow$ and so the probability that polluters are able to break even $\downarrow$, bankruptcy rate and monitoring costs $\uparrow$, interest rate spread $\uparrow$, return on polluting production $\downarrow$ so investments $\downarrow$, polluters' production $\downarrow$ and final output $\downarrow$
  - Second-round effects: the higher cost of borrowing decreases the expected return on capital and so investment and the price of capital $\downarrow$, so net worth $\downarrow$ etc...
- **The return on polluting production depends on environmental policy!**

IRFs to a Risk Shock

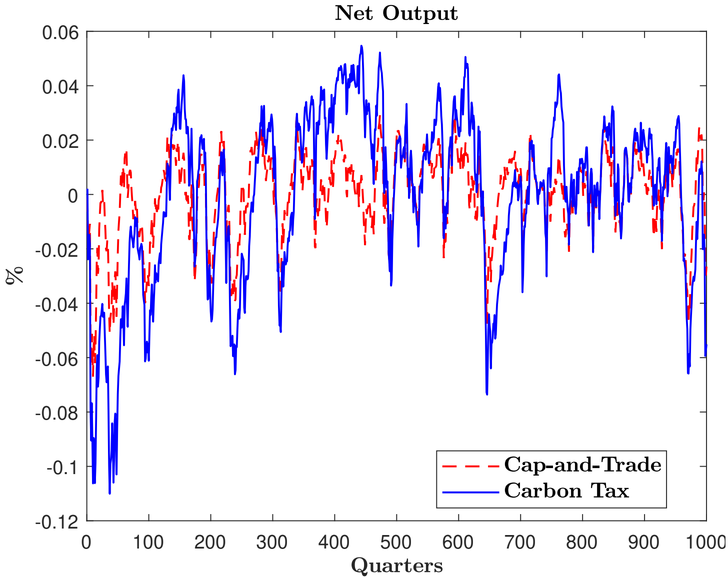


IRFs to a Risk Shock



Results reported as % deviations from the steady state

Simulated Series - Net Output Dynamics



Environmental Variables Means and (Volatility)

	Cap-and-Trade	Carbon Tax
Emissions	-	-4.1252
	-	(0.0073)
Carbon Price	-60.1306	-
	(0.1781)	-
Rel. Compliance Costs	-62.5687	0.8998
	(0.0029)	(0.0001)

Note: Results are reported in % deviations from the steady state.

Back to welfare costs

Different Measures of Welfare Costs of the Business Cycle

	Cap-and-Trade	Carbon Tax
Unconditional Expectation	0.6178	1.5231
Conditional Expectation	0.5457	1.1294
Unconditional Compensating Variation	0.4634	1.1423
Conditional Compensating Variation	0.4093	0.8470

Back to welfare costs

Welfare Costs - Sensitivity

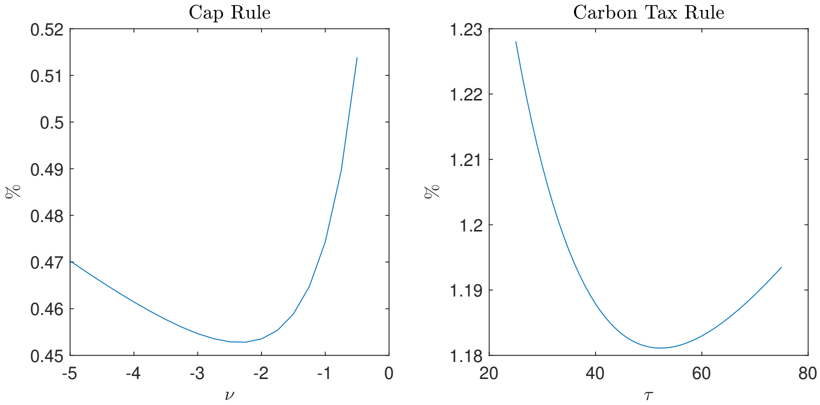
	Cap-and-trade	Carbon Tax
Baseline $\theta_2 = 2.6, \mu = 0.2, RRA = 2, \gamma_I = 20$	0.6178	1.5231
Abatement Cost		
$\theta_2 = 2$	0.2477	1.5230
$\theta_2 = 3$	0.7969	1.5233
Monitoring Cost		
$\mu = 0.01$	0.2276	0.3634
$\mu = 0.1$	0.5660	1.1905
$\mu = 0.8$	0.6529	2.0039
Relative Risk Aversion		
RRA $= 1.5$	0.6045	1.4231
RRA $= 5$	0.8618	3.1093
Curvature of investment technology		
$\gamma_I = 5$	0.5566	1.4501
$\gamma_I = 25$	0.6247	1.5647

Back to welfare costs

Welfare Costs of the Business Cycle - Source of Shocks

	Cap-and-Trade	Carbon Tax	Cost Ratio
All shocks	0.6178	1.5231	2.47
TFP	0.0297	0.0495	1.67
Risk shock	0.5885	1.4750	2.51

Welfare Costs under Hybrid Environmental Policy Rules



- 'Lean against the wind' policies $\rightarrow$ more uncertain compliance costs

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Environmental Variables Means and (Volatility)

	Optimal Cap-and-Trade	Optimal Carbon Tax
Emissions	1.2752	-3.0437
	(0.0034)	(0.0044)
Carbon Price	-3.6366	-5.3199
	(0.3821)	(0.0788)
Rel. Compliance Costs	-17.1351	-10.2686
	(0.0062)	(0.0012)

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Welfare Costs, Means and (Volatility) - Static Macropru

	Cap-and-Trade	Carbon Tax
Net Output	-0.2007	-0.4796
	(0.0089)	(0.0147)
Consumption	-0.1672	-0.3864
	(0.0069)	(0.0098)
Investment	-0.3655	-0.9397
	(0.0044)	(0.0089)
Net worth	5.4258	5.0493
	(0.3884)	(0.3544)
Spread	0.0437	0.0670
	(0.0025)	(0.0027)
Welfare costs	0.1957	0.3863

Note: Results are reported in % deviations from the steady state (spread in p.p.d.). Welfare in consumption equivalent units

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Environmental Variables Means and (Volatility) - Static Macropru

	Cap-and-Trade	Carbon Tax
Emissions	-	-0.9951
	-	(0.0025)
Carbon Price	-19.7031	-
	(0.1078)	-
Rel. Compliance Costs	-20.6689	0.1574
	(0.0018)	(0.00003)

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Steady-State under Different Macroprudential Policies

	Baseline	Reserve	Subsidy
Output Y	1.00	0.85	1.11
Investments I	0.20	0.14	0.25
Leverage L	2.01	1.73	2.12
Bankrupt business p/quarter $F(\overline{\omega})$ %	1.50	0.32	2.11
Return spread p.p. $R^k - R$	1.51	2.49	0.99
Welfare	-62.60	-67.65	-60.08

Note: The return spread under the subsidy policy is computed as $R^k - R - s^*$.

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Macroprudential Regulation

Baseline $\Phi_t = 1$	1.5522
$\Phi_t = \Phi^\star$	0.3910
$\Phi_t = \Phi^\star \left(\frac{B_{t+1}}{B_t}\right)^{-\psi^B}$	0.3259 $\psi^B = 1.0000$
$\Phi_t = \Phi^\star \left(\frac{Q_{K,t}}{Q_{K,t-1}}\right)^{-\psi^Q}$	0.2339 $\psi^Q = 0.6750$

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References

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